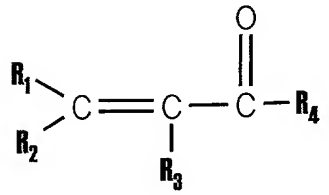
WHAT IS CLAIMED IS:

1. A method of partially or completely encapsulating radioactive particles comprising: exposing radioactive particles or material, alone or in combination with other materials, to a precursor monomer solution that is capable of polymerizing in situ due to the inherent radiation of the radioactive material, whereby the radioactive material is partially or totally encapsulated in the resultant polymer.

2. The method as in claim 1, wherein the precursor monomer solution comprises monomers capable of forming hydrogel polymers.

3. The method as in claim 1, wherein the precursor monomer solution comprises one or more monomers selected from the group of water-soluble, ethylenically-unsaturated acids and acid derivatives.

4. The method as in claim 3, wherein the water soluble ethylenically unsaturated acids and acid derivatives have the general formula:



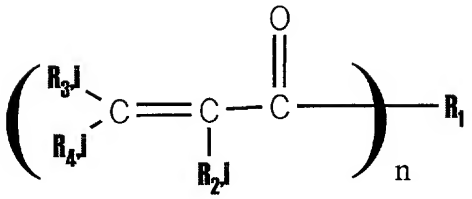
wherein R1, R2, and R3 are independently selected from the group consisting of H, C, C2-C6 alkanes, C2-C6 alkenes, C2-C6 alkynes, aromatics, halogens, carboxylic acid derivatives, sulfates and nitrates; and

R4 is selected from the group consisting of NR5, NHR5, NH2, OH, H, halides, OR5, and carboxylic acid derivatives, wherein R5 is selected from the group consisting of H, C, C2-C6 alkanes, C2-C6 alkenes, C2-C6 alkynes, and aromatics.

5. The method as in claim 3, wherein the water soluble ethylenically unsaturated acids and acid derivatives are selected from the group consisting of methylenebisacrylamide, acrylamide, methacrylic acid, acrylic acid, fumaramide, fumaric acid, N-isopropylacrylamide, N, N-dimethylacrylamide, 3,3-dimethylacrylic acid, maleic anhydride, and combinations comprising at least one of the foregoing ethylenically unsaturated acids and derivatives.

6. The method as in claim 1, wherein the precursor monomer solution comprises one or more monomers selected from the group of water-soluble, ethylenically-unsaturated acids and acid derivatives and a crosslinking agent.

7. The method as in claim 6, wherein the crosslinking agent is of the general formula:



wherein i=1 n, and n≥2;

R2,i, R3,i, and R4,i are independently selected from the group consisting of H, C, C2-C6 alkanes, C2-C6 alkenes, C2-C6 alkynes, aromatics, halogens, carboxylic acid derivatives, sulfates and nitrates;

R1 is selected from the group consisting of N, NR5, NH, O, and carboxylic-acid derivatives, wherein R5 is selected from the group consisting of H, C, C2-C6 alkanes, C2-C6 alkenes, C2-C6 alkynes, and aromatics.

8. The method as in claim 6, wherein the crosslinking agent is selected from the group consisting of methylenebisacrylamide, ethylenebisacrylamide, any water-soluble N,N'-alkylidene-*bis*(ethylenically unsaturated amide), 1,3,5-Triacryloylhexahydro-1,3,5-triazine, and combinations comprising at least one of the foregoing crosslinking agents.

9. The method as in claim 1, wherein the precursor monomer solution comprises one or more monomers selected from the group of water-soluble, ethylenically-unsaturated acids and acid derivatives and a reinforcing element.

10. The method as in claim 2, wherein the reinforcing element comprises a water-soluble or water-swellable polymer is selected from the group consisting of polysulfone (anionic), poly(sodium-4-styrenesulfonate), carboxymethyl cellulose, polysulfone (anionic), sodium salt of poly(styrenesulfonic acid-co-maleic acid), corn starch, any other water-soluble or water-swellable polymers, and combinations comprising at least one of the foregoing polymers.

11. The method as in claim 1, wherein the precursor monomer solution comprises one or more monomers selected from the group of water-soluble, ethylenically-unsaturated acids and acid derivatives and a photo-initiator.

12. The method as in claim 11, wherein the photo-initiator is selected from the group of photo-initiators consisting of disulfides, benzoin, benzil, 1-phenyl-2-methyl-2-hydroxypropanone, 4,4'-diazidostilbene-2,2'-disulfonic acid disodium salt, benzenediazonium 4-(phenylamino)-sulfate, formaldehyde, 2-(2-(vinyloxy)ethoxy)-ethanol, and combinations comprising at least one of the foregoing photo-initiators.

13. The method as in claim 1, wherein the precursor monomer solution comprises an aqueous solvent.

14. The method as in claim 1, wherein the precursor monomer solution comprises an organic solvent.

15. The method as in claim 14, wherein the precursor monomer solution further comprises

a monomer selected from the group consisting of styrene, isoprene, methyl methacrylate, 4-methylsterene, acrylonitrile, vinyl acetate, and combinations comprising at least one of the foregoing monomers.

16. The method as in claim 1, wherein the precursor monomer solution comprises an additives to facilitate separation and/or collection selected from the group consisting of dyes, heavy powders, and magnetic materials.

17. A method of separating a radioactive particles from a combination of radioactive particles and non-radioactive particles comprising:

exposing the combination to a precursor monomer solution that is capable of polymerizing in situ due to the inherent radiation of the radioactive material, whereby the radioactive material is partially or totally encapsulated in the resultant polymer, and

separating the encapsulated radioactive particles from the non-radioactive particles.